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Patentanmeldung Nr. / Patent application No. / Demande de brevet n°

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For the President of the European Patent Office

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R C van Dijk

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Display device comprising a light guide

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Display device comprising a light guide

The invention relates to a dynamic foil display device as defined in the pre-characterizing part of Claim 1. The invention also relates to a method for operating a dynamic display device.

A dynamic foil display device of the type mentioned in the opening paragraph is known from the international patent application WO 00/38163.

The known dynamic foil display device comprises a light source, a light guide, a second plate which is situated at some distance from the light guide and, between said two plates, a moveable element in the form of a membrane. By applying voltages to addressable electrodes on the light guide, the second plate, and an electrode on the membrane, the membrane can be locally brought into contact with the first plate, or the contact can be interrupted. In operation, light generated by the light source is coupled in the light guide. At locations where the membrane is in contact with the light guide, light is decoupled from said light guide. This enables an image to be represented. A possible selection method for selecting the locations of the membrane at the crossing areas of the addressable electrodes is a multiple line addressing method. Grey scales can be obtained by the multiple line addressing method in combination with pulse width modulation. In this case, a picture is displayed at a frame rate of 60 Hz. A first voltage is supplied to a first line. At t=0 a first voltage V0 is supplied to a row electrode. This will activate the line corresponding to said row electrode. Simultaneously, voltages Von for those crossing areas where the pixel have to be turned on, are supplied to the column electrodes crossing said row electrode. Application of a Vhold at either one of the electrodes preserves the state of the pixel. At t=t1 the electrode is supplied with a voltage Voff. This will blank the line. The blanking time takes ts. After a short waiting time td the line is activated again. The video information can then be changed for each electrode crossing the relevant row electrode. Thus, the first time the pixel can be 1τ on, the second time 2τ off, the third time 4τ on etc. For an 8-bit grey scale a complete cycle comprises for example, 8 sub periods of lengths 2,4,8,16,32,64,128τ. Furthermore, two sub-periods are separated by an off-on sequence taking $\tau s+\tau d+\tau s$. These steps are repeated for the

other row electrodes of the display device. Multi-line addressing of the dynamic foil display device and grey levels can thus be made.

Thereto the lines of the dynamic foil display device are interconnected in a number of groups of spatially subsequent addressed lines and the individual groups are addressed sequentially. A disadvantage of the known dynamic foil display device is that, in case a uniform grey image has to be displayed, the luminance of subsequent pixels along one of the lines of the display varies along the width of the display device.

It is an object of the invention to provide a dynamic foil display device of the type mentioned in the opening paragraph having an improved homogeneity.

To achieve this object, a first aspect of the invention provides a dynamic foil display device as specified in Claim 1. The invention is based on the recognition that in a grey-level dynamic foil display two causes of light losses exists; a first cause is the coupling out of light needed for light generation associated with the picture element and a second cause is the absorption in spacers, glass, and conducting coatings. The first cause depends heavily on the contents of the image to be displayed. Applying multi-line addressing on spatially adjacent addressed selection electrodes for displaying a predetermined grey value on the display causes a variance in the luminance along a first direction of the display perpendicular to a second, lateral direction. The lateral direction corresponds to the main direction of light flux from the light source in the light guide. Furthermore, in the lateral direction a stepwise variation in the displayed grey value may occur at the position where the first selection electrodes of a new addressing group begins. These stepwise variations are caused at the position of the first addressed selection electrode of a new group because the first selection electrode of this group is addressed at a later instant than the selection electrodes of the former group so that light loss through coupling out of the light has not occurred yet in the light guide. In case the successively addressed lines of a single addressed group are evenly distributed over the height of the display the effect of attenuated rays with a first distinct angle with respect to the surface of the light quite is average out with non-attenuated rays with a second distinct angle with respect to the surface of the light guide, whereby the second distinct angle is slightly different from the first distinct angle. So, the homogeneity of the dynamic foil display is improved. In this application evenly distributed means distributed in a balanced or impartial way. Further advantageous embodiments of the invention are specified in the dependent claims.

In an embodiment as specified in claim 3 the dynamic foil display device acts as a subfield modulated display. Thus a display element can only turn pixels on and off. In a

subfield, a display element can be conditioned to scatter light in the display period. Therefore, an addressing sequence is necessary, in such a way that the moveable element is locally forced against the light guide when an appropriate voltage is applied between the first and second electrodes in addressing period. In the subsequent display period, when the light source is emitting light, at the selected display element, the moveable element scatters light from the light guide to the viewer. In the next subsequent subfield this process is repeated. The weight of the subfield determines how long the light source will emit light. The luminance of a display element may be determined by an input byte of the displayed image. The weight of the subfields corresponds to the weight of the input bits of a display element, when the weight of a bit corresponds to the weight of the subfield at a display element, the moveable element will scatter light during the subsequent display period. Because, in the new display device, all lines are active at the same time, fixed pattern noise in the displayed image can be reduced.

In an embodiment as specified in claim 5 a color image can be displayed in a color sequential way. In this color sequential dynamic foil display device, the image information can be divided in subfields associated with image information of the two colors respectively and the weighting of the subfields of each color is related to the levels of each color. The driving means are arranged for driving the light source associated with the color of the displayed subfield. In this arrangement, color filters per display element are not required any more which improves the light efficiency of the display device. A further advantage of the evenly distribution of the lines of the different groups over the entire display is that a so-called color flash effect is recuded.

The color flash effect occurs in case a number of adjacent lines of the same group is addressed.

In an embodiment as specified in claim 9 the display device comprises a mirror at the side of the light guide facing away from the moveable element. By applying this mirror in a display device applying a color sequential addressing method, the light efficiency can be improved without introducing parallax in the display device. In conventional display devices using red, green and blue color filters such a mirror may give rise to unacceptable parallax.

A further embodiment of the dynamic foil display device can be provided with a light emitting diode or a laser source. Important is that the light source can be switched on and off in a period much shorter that the period in which the light source emits light, associated with the lowest weight factor.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a cross-sectional view of a display device with a membrane,

Fig. 2 shows a detail of the display device shown in Fig. 1,

Fig. 3 shows an addressing scheme for a the display device shown in Fig. 1,

Fig. 4 shows a distribution of addressed selection electrodes in two groups in a convention multi-line addressing scheme,

Fig. 5 shows an improved distribution of addressed selection electrodes in two groups in an improved multi-line addressing scheme,

Fig. 6 shows an example of a test image,

Fig. 7 shows a graph of a luminance distribution of the known multi-line addressing scheme.

Fig. 8 shows a graph of a luminance distribution of the new multi-line addressing scheme.

Fig. 9 shows schematically a sub-field modulated dynamic foil display,

Fig. 10 shows an addressing sequence of a sub-field modulated dynamic foil device.

Fig. 11 shows an addressing sequence of a color sequential sub-field modulated dynamic foil device, and

Fig. 12 shows a dynamic foil display device provided with a mirror behind the light guide.

The Figures are schematic and not drawn to scale, and, in general, like reference numerals refer to like parts.

Fig. 1 schematically shows a display device 1 comprising a light guide 2, a moveable element 3 and a second plate 4. In this example, the moveable element comprises a membrane. The membrane 3 may be made of a transparent polymer having a glass transition temperature of at least the operating temperature of the display device in order to prevent non-elastic deformation of the membrane. Practically, the operating temperature of the

display device is in the range between about 0 and 70 degrees Celsius. A suitable transparent polymer is, for example, parylene which has a glass transition temperature of 90 degrees Celsius.

Electrode systems 5 and 6 are arranged, respectively, on the surface of the light guide 2 facing the membrane 3 and on the surface of the second plate 4 facing the membrane. Preferably, a common electrode 7 is arranged on a surface of the membrane 3. The common electrode 7 can be formed by for example a layer of indium tin oxide (ITO). In this example, the light guide is formed by a light-guiding plate 2. The light guide 2 may be made of glass. The electrodes 5 and 6 form two sets of electrodes, which cross each other at an angle of preferably 90°. A set of selection electrodes or row electrodes 6 and a set of data electrode or column electrodes 5. By locally generating a potential difference between the electrodes 5, 6 and the membrane 3, by applying, in operation, voltages to the electrodes 5, 6 and electrode 7 on the membrane 3, forces are locally exerted on the membrane, which pull the membrane 3 against the light guide 2 or against the second plate 4.

The display device 1 further comprises a light source 9 and a reflector 10. Light guide 2 has a light input 11 in which light generated by the light source 9 is coupled into the light guide 2. The light source may emit white light, or light of any color, depending on the device. It is also possible that more than two light sources are present, for instance, a light source on two sides or on each side of the device. It is also possible to use light sources of different colors sequentially driven to form a white light display.

The membrane 3 is positioned between the light guide 2 and the second plate 4 by means of sets of spacers 13. Preferably, the electrodes systems 5, 6 are covered by respective insulating layers 12 and 14 in order to preclude direct electric contact between the membrane 3 and the electrodes. By applying voltages to the electrodes 5,6,7 an electric force F is generated, which pulls the membrane 3 against the electrode 5 on the light guide 2. The electrode 5 is transparent. The contact between the membrane 3 and the light guide 2 causes light to leave the light guide 2 and enter the membrane 3 at the location of the contact. The membrane scatters the light and a portion of the scattered light leaves the display device 1 via the transparent electrode 5 and the light guide 2 and an other portion of the scattered light leaves through the second plate 4. It is also possible to use one set of transparent electrodes, the other being reflective, which increases the light output in one direction. The common electrode 7 comprises an electrically conducting layer. Such an electrically conducting layer can be a semi-transparent metal layer, such as a semi-transparent aluminium layer, a layer of

a transparent electrically conducting coating such as indium tin oxide (ITO) or a mesh of metal tracks.

In operation, the light travels inside the light guide 2 and, due to internal reflection, cannot escape from it, unless the situation as shown in Figure 2 occurs. Fig. 2 shows the membrane 3 lying against the light guide 2. In this state, a part of the light enters the membrane 3. This membrane 3 scatters the light, so that it leaves the display device 1. The light can exit at both sides or at one side. In Fig. 2, this is indicated by means of arrows. In embodiments, the display device comprises color-determining elements. These elements may be, for example, color filter elements allowing light of a specific color (red, green, blue, etc.) to pass. The color filter elements have a transparency of at least 20% for the spectral band width of a desired color of the incoming light and for other colors a transparency in the range between 0 and 2% of the incoming light. Preferably, the color filter elements are positioned at surface of the second plate 4 facing the light guide 2.

Fig. 3 shows an example of a known addressing scheme for the display device 1. This known addressing scheme is a so called multiple row addressing technique. A detailed description of this addressing technique can be found in the international patent application WO 00/38163, which is an earlier patent application of the same applicant. This method of addressing is very interesting, since it allows for switching of the membranes on or off with a single force acting on the structure. Fig. 3 shows three addressing states

- a first addressing state "On" 20,
- a second addressing state "Nothing happens due to bi-stability",21
- and a third addressing state "Off" 22.

The a first graph 16 indicates the voltage on the column electrode 5, a second graph 17 indicates the voltage on the row electrode 6 and a third graph 18 indicates the voltage on the common electrode 7. It can be seen that during switching only a single force acts on the membrane. The fourth graph 19 indicates the on/off state of the corresponding display element.

For a VGA display consisting of 480 lines and 600 columns, the row electrodes 6 can be connected in, for example, 10 groups of 48 row electrodes. In an addressing period, the row drivers 43 supply scan pulses to 48 row electrodes 6 and data pulses Di to the column electrodes 5 such that only those portions of the membrane 3 corresponding to display elements that will scatter light in the subsequent display period move about in contact with the light guide 2.

In a conventional multi-line addressing scheme, spatially adjacent row electrodes 23,24 of a respective groups BLK1, BLK2 are successively addressed one after each other and the subsequent groups BLK1, BLK 2 are sequentially activated as shown in Fig.4.

In order to provide a more uniform grey scale image over the entire display the row electrodes 25,26 are addressed in such a way that the successively addressed row electrodes 25,26 are evenly distributed over the front area of the light guide 2 as shown in fig. 5. Fig 5 gives an example of a new multi-line addressing scheme of successively addressing of spatially distributed row electrodes 25,26 of the respective groups over the display leading to an improved uniformity of the display wherein the successively addressed rows 25,26 of subsequent groups BLK10,BLK20 are evenly distributed. Preferably, in such a way that a single row electrode 25 addressed in a first group BLK10 is in between two single row electrodes 26 addressed in a second group BLK20. Furthermore, it is assumed that the light is coupled into the light guide via one of the short sides of the display, so the distribution of the row electrodes is along the main direction of the light flux from the light source in the light guide.

Alternatively, the row electrodes can be addressed in a way that a pair of adjacent row electrodes 25 addressed in a group BLK10 is in between two pairs of adjacent rows 26 of a second group BLK20.

A simulation result showing the difference between the conventional multi-line addressing scheme and the new multi-line addressing scheme is discussed with a test image as shown in Fig. 6. Fig. 6 shows an example of a test image 27 containing a white square WT of dimensions 10x 10 mm2 in the left corner of a rectangle of dimensions 100x60 mm2, the rectangle consisting further of a black rectangle 28 of dimensions 10x50 mm2 and an adjacent grey rectangle GRS 90x60 mm2.

Fig. 7 shows a first graph 31 of a simulation of a luminance distribution on a dynamic foil display device displaying the test image 27 wherein a conventional multi-line addressing scheme of row electrodes 23,24 in a group BLK1,BLK2. The first graph 31 shows a relative difference of a factor 2 over the width of the display. Furthermore, within each group a variation in the grey value is present, and the transitions 33 between adjacent groups along the length of the display are noticeable as a step increase of the luminance, these step increases are caused by a later addressing instance of the new subsequent group, where, for that later addressing instances, no light losses have yet occurred due to the

coupling out of light, except for a constant light loss due to absorption along the light guide 2.

Fig. 8 shows a second graph 37 of a simulation of a luminance distribution of the dynamic foil display device displaying the test image wherein the new multi-line addressing scheme of the row electrodes 25,26 in groups BLK10,BLK 20 is applied, in which new multi-line addressing scheme, the successively addressed row electrodes 25,26 of the groups BLK10,BLK20 are evenly distributed over the entire display. Fig 8 shows that the relative difference in luminance along the width of the display is reduced to about 10%. Also the variance in the graph 37 along the length of the display has been smoothed compared to graph 31 of Fig 7. Note that the origin of both graph 31,37 in Figs. 7 and 8 is at 10 mm distance of the side of the display, so where the grey rectangle GRS in the test image 24 begins.

The new multiline addressing scheme with evenly distribution of the addressed row electrodes 25,26 over the dynamic foil display is also advantageous in color sequential dynamic foil displays because of a reduction of the color flash effect.

Fig. 9 shows schematically an example of a sub-field modulated dynamic foil display 40 comprising a timing circuit 42, row and column drivers 43,46 and a lamp drive circuit 47. The timing circuit 42 receives information to be displayed on the display device. The timing circuit 42 divides a field period Tf of the display information into a predetermined number of consecutive subfields Tsf. Red, green and blue color filters associated with the display element together with a white light source. This light source can be for example a red, a green and a blue led 49,51,53 together with the lamp drive circuit 47 arranged for simultaneously driving each of the LEDs 49, 51,53 such that white light is emitted, composed from a mixture of the red, green and blue light of the LEDs 49,51, 53. Assume, the response time to switch the membrane 3 to the light guide 2 is τs. This is roughly half of the time the membrane needs to cross the distance between the light guide and the front plate. A practical value for this response time is 3μs. A subfield period comprises an addressing period, a display period and a reset period.

For a VGA display consisting of 480 lines and 600 columns, the row electrodes 6 can be divided in, for example, 10 groups of 48 row electrodes. In case a multi-line addressing scheme is applied in an addressing period, the row drivers 43 supply scan pulses to 48 row electrodes 6 and data pulses Di to the column electrodes 5 such that, only those portions of the membrane 3 corresponding to display elements that will scatter light in the subsequent display period, move about in contact with the light guide 2. To provide an

improved image homogeneity, the successive addressed row electrodes 6 of one group are evenly distributed over the light guide in a direction coinciding with the main direction of the light flux from the light source in the light guide. This distribution of rows provides a more uniform grey scale image over the entire display. The time needed for these addressing period is $N x \tau s$, wherein N represent the number of row electrodes 6. In the consecutive display period, the row and column driver 43,46 will supply a hold signal to the respective row and column electrodes 5,6. During the display period, the lamp drive circuit 47 supplies a drive pulse to the LEDs 49,51,53. The timing circuit 42 further associates a fixed order of weight factors Wf to the subfield periods Sf in every field period Tf. The lamp drive circuit 47 is coupled to the timing circuit 42 to supply the drive pulse Ld having a duration in conformance with the weight factors Wf such that the amount of light generated by a display element corresponds to the weight factor. In the subsequent reset period, the row drivers 43 supplies row-reset-pulses to the selected 48 row electrodes, and a data drivers 46 supplies column-reset-pulses to the column electrodes 4 for releasing the selected portions of the membrane 3 which are in contact with the light guide from that light guide 2.

Furthermore, a subfield data generator 55 performs an operation on the display information Pi such that the data Di is in conformance with the weight factors Wf. In this way, only display elements in conformance with image data Di will scatter light in the display period.

In the display device three different state can then be distinguished:

an preparing phase, wherein in dependence of data Di the membrane will be in contact with the light guide or released. Therefore, the display elements are addressed at "a line at a time" basis and the voltage levels on the columns electrodes will determine the position of the membranes.

A display phase, wherein a drive signal is supplied to the LEDs, the weight of an individual luminance bit will determine the presence of a light pulse during the display phase.

It may occur that light pulses Lpi,n in subsequent field periods are generated according the weight of least and the most significant bit in the image information supplied; and

a reset phase, wherein all portions of the membrane of the display elements which are in contact with the light guide 2 are released from the light guide 2. This process is repeated for all 10 groups of the row electrodes 6.

Fig. 10 shows a control sequence for a group of 48 row electrodes of a sub-field modulated dynamic foil display device. The control sequence comprises addressing periods S1,..S8 and display periods 57,..,64. For 480 lines and 256 grey values the total addressing time is 10x 8 x (48 +1) x τs. In case τs equals 3 µs the total addressing time is 11.76 ms and remains 8.24 ms for generating light. So, for a single group the total addressing time is 1.176 ms and remains 0.824 ms for generating light.

For a 256 grey value system and 10 groups of row electrodes, in the display period, the duration of the interval, in which the LEDS are emitting light, associated with the least significant bit is approximately 3 µs and the duration of the interval, in which the LEDs are emitting light, associated with the most significant bit is approximately 0.4 ms. For the LED's a switching time lower than 0.1 µs is required. The applied LED's 49,51,53 should withstand high peak loads. Instead of the LED's 49,51,53 also solid state lasers can be applied.

This mode of addressing can be useful for displaying VGA or SVGA images, NTSC or PAL television images.

In an other embodiment a color sequential display method is applied in the sub-field modulated dynamic foil display device.

Schematically, this color sequential subfield modulated dynamic foil display device comprises similar circuits 40,42,43,45,47,as the dynamic foil display device 40 as described with relation to Fig. 9 except that the timing circuit 42 is now arranged to divide a field period Tf of the display information into a predetermined number of consecutive subfields Tsf associated with red, green and blue information, respectively, of the image to be displayed. The lamp drive circuit 47 is arranged for driving the LED in the color of the display period associated with the subfield corresponding to the red, green and blue image information, respectively. In this display device, the required response time to bring a portion of the membrane 3 the light guide 2 should be 1µs. This is roughly half of the time the membrane needs to cross the distance between the light guide 2 and the front plate 4. A subfield period comprises an addressing period, a display period and a reset period.

For a VGA display the row electrode can again be divided in, for example 10 groups of 48 lines. In an addressing period, the row drivers 43 supply scan pulses to 48 row electrodes 6 and the column drivers 45 supply data pulses Di to the column electrodes 5 such that only those portions of the membrane 3 corresponding to display elements that will scatter light in the subsequent display period move about in contact with the light guide 2. Preferably, the row electrodes 5 of each group have been evenly distributed over the light

guide 2. The time needed for these addressing period is 10 x 3 x 8 (48 +1)xτs. In the consecutive display period, the row and column driver 43,45 will supply a hold signal to the respective row and column electrodes 5,6. During the display period, the lamp drive circuit 47 supplies a drive pulse to the red, green or blue LED 49,51,53 in accordance with the color of the processed subfield. The timing circuit 42 further associates a fixed order of weight factors Wf to the subfield periods Sf in every field period Tf. The lamp drive circuit 47 is coupled to the timing circuit 42 to supply the drive pulse Ld having a duration in conformance with the weight factors Wf such that the amount of light generated by a display element corresponds to the weight factor. In the subsequent reset period, the row drivers 43 supplies a row-reset-pulse to the selected 48 row electrodes, and a data driver 46 supplies column-reset-pulse to the second electrodes or column electrodes 5 for releasing the portions of the membrane 3 from the light guide 2. This addressing requires only a single addressing period. This process is repeated for all subfields for red, green and blue information respectively and for all groups. A subfield data generator 55 performs an operation on the display information Pi such that the data Di is divided for subfield associated with red, green and blue colors and in conformance with the weight factors Wf. In this way, only display elements in conformance with image data Di will scatter red, green or blue light in the display period.

Fig 11 shows a control sequence for a group of 48 row electrodes of a color sequential sub-field modulated dynamic foil display device. The control sequence 65 comprises addressing periods Sr1,..Sr8, Sg1,..,Sg8, Sb1,..Sb8 and display periods 66,..,73 For 480 lines and a 256 grey value system the total addressing time in the sequential color display device is 10x3x8 (48+1) xτs. In case τs equals 1 μs the total addressing time is 11.7 ms and remains 8.3 ms for generating light. Per group this last interval for generating light is 0.83 ms. The interval for generating light in one of the three colors is then 0.277 ms. For an 256 grey value system, in the display period, the duration of the interval in which the one of the LEDs are radiating light associated with the least significant bit is approximately 1.1 μs and the duration of the period in which one of the LEDs are radiating light associated with the most significant bit is approximately 138 μs. For LED's or solid state laser a switching time lower than 0.1 μs. It is clear that the light sources should withstand high peak loads. It has to be noted that to avoid a loss of efficiency an integrated intensity Is of the LED's should be comparable with the intensity Ib of a continuous light source. Practically, this means that that the intensity of the LEDs Ils should be

$Ils\ 0.824 = Ib\ 20\ ms \Rightarrow Ils = 24.27\ Ib.$

This mode of addressing can be useful for displaying VGA or SVGA images, NTSC or PAL television images.

Furthermore, in order to increase the brightness with an additional factor two a mirror can be positioned at the side of the light guide facing away from the membrane.

Fig 12 shows a dynamic foil display device 74 comprising a mirror 76 behind the light guide 2 at the side directed away from the second plate 4. The portion of the membrane 3 scatters a first portion 78 of the light in a direction to the viewer and a second portion 80 backwards to the mirror 76. The mirror 76 reflects the second portion 80 of the direction of the viewer.

It will be obvious many variations are possible within the scope of the invention without departing from the scope of the appended claims.

CLAIMS:

1. A dynamic foil display device for displaying image information comprising a light source for generating light,

a light guide for transporting of the generated light,

a plurality of controllably moveable elements associated with the light guide for locally bringing, in an active state, said moveable element into contact with the light guide for coupling out light from the light guide so as to form a picture;

selection means comprising selection electrodes and data electrodes arranged in row and columns respectively for controlling the moveable elements in correspondence with a received image information, wherein the selection electrodes are interconnected in a first and a second group of rows;

and driving means being arranged to provide the image information to the selection means corresponding to the rows of the first group and the rows of the second group respectively characterized in that the selection electrodes of the first group and the selection electrodes of the second group are distributed evenly in a lateral direction, parallel to a main direction of the light flux in the light guide.

2. A display device as claimed in claim 1, wherein a selection electrode of the first group is located between neighbouring selection electrode of the second group.

3. A display device as claimed in claim 1, wherein the display device comprises timing means for dividing a field period of the received display information into consecutive subfields having an addressing period preceding a display period, the timing means further generating with the field period a predetermined order of weight factors each associated with a corresponding one of the display periods; a light source driver which upon receiving a drive signal activates the light source during the display period and a driver circuit for supplying a drive signal corresponding to the weight factors to light course driver.

4. A display device as claimed in claim 4, wherein the received display information comprises data words having binary coded weights, and the timing means are

adapted to generate the weight factors of the display periods within a field period such that each weight factor corresponds with one of the weights of the bits.

5. A display device as claimed in claim 5, wherein the light source comprises a first light source of a first color and a second light source of a second color and the timing means are further arranged for dividing the field period of the received display information into consecutive first subfield periods associated with the first color and consecutive second subfield periods associated with the second color and the drive circuit is further arranged for supplying the drive signal corresponding to the weight factors to the light source with the color associated with the subfield period.

6. A display device as claimed in claim 1 wherein the display device comprises a reflective element at the side of the light guide directed away from the moveable element.

7. A display device as claimed in claim 1, wherein the light source comprises a light emitting diode.

8. A display device as claimed in claim 1, wherein the light source comprises a laser.

9. A method of driving a flat panel display in a subfield mode, the flat panel display comprising a plurality of picture elements arranged in matrix of row and columns, selection electrodes and data electrodes associated with picture elements in a row or column, and a light source for generating light, the display elements are arranged, when in an active state, for transmitting light from the light source in conformance with received display information, the method comprising a step of sequentially addressing the selection electrode in a first group and a second group respectively characterized in that the method comprising a further step of evenly distributing the addressed selection electrodes in a direction parallel to the main direction of the light flux in the light guide.

ABSTRACT:

A display device comprises row (5) and column (6) electrodes and a moveable element (3) and means (17) for supplying voltages to the electrodes. Therewith a controllable image element is formed on a crossing of the electrodes. In dependence of driving pulses received by the electrodes the moveable element can be set either to the front plate or the back plate. At one side of the light guide light from a light source in couples in the light guide, when the moveable element is in contact with the light guide light is tapped out from the light guide at that place. The display device can be addressed by a multiple line addressing scheme. By distributing the respective lines of the different groups evenly over the display the homogeneity of the display is improved. In case this distribution of row is applied in a color sequential dynamic foil display the color flash effect is reduced.

Fig. 5

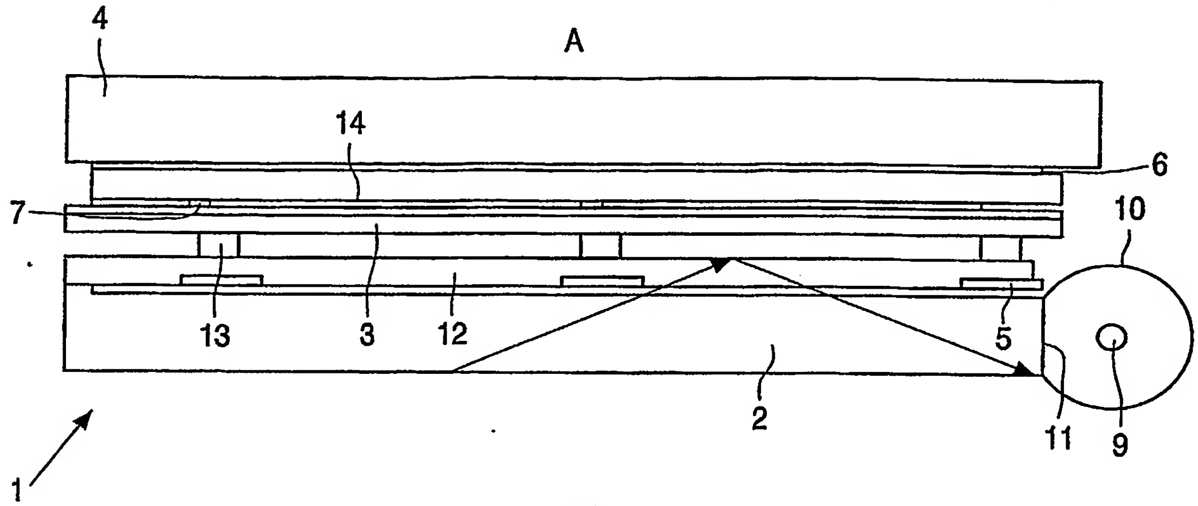

FIG. 1

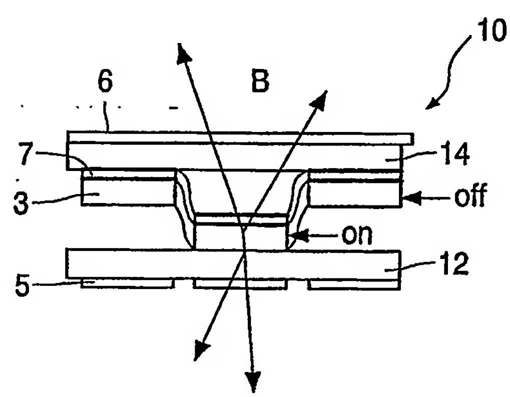

FIG. 2

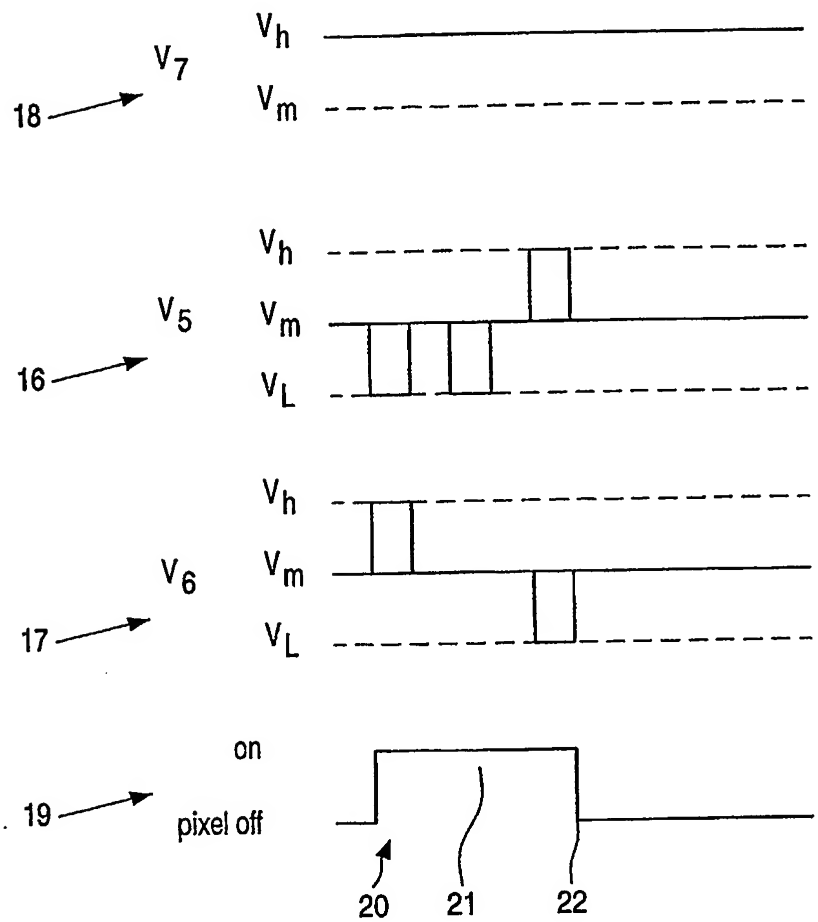

FIG. 3

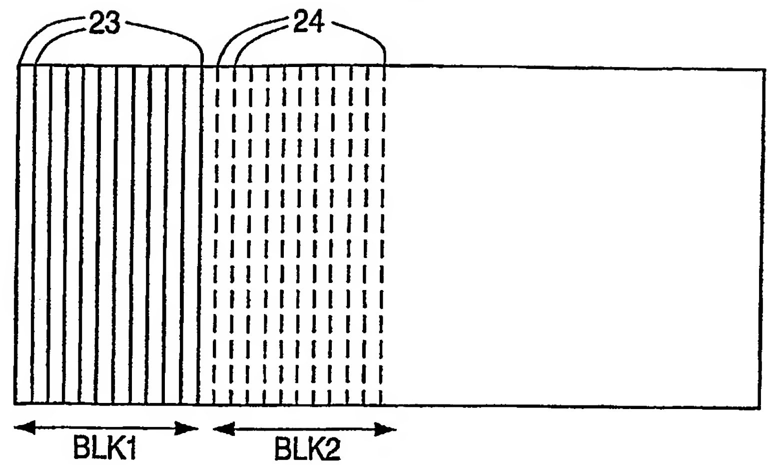

FIG. 4

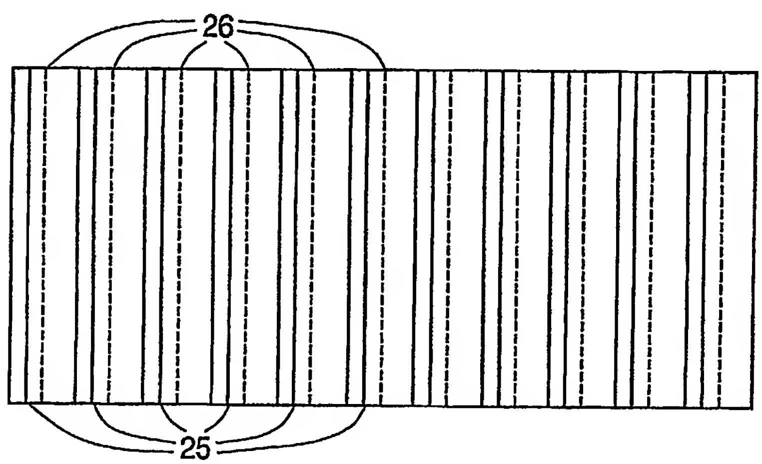

FIG. 5

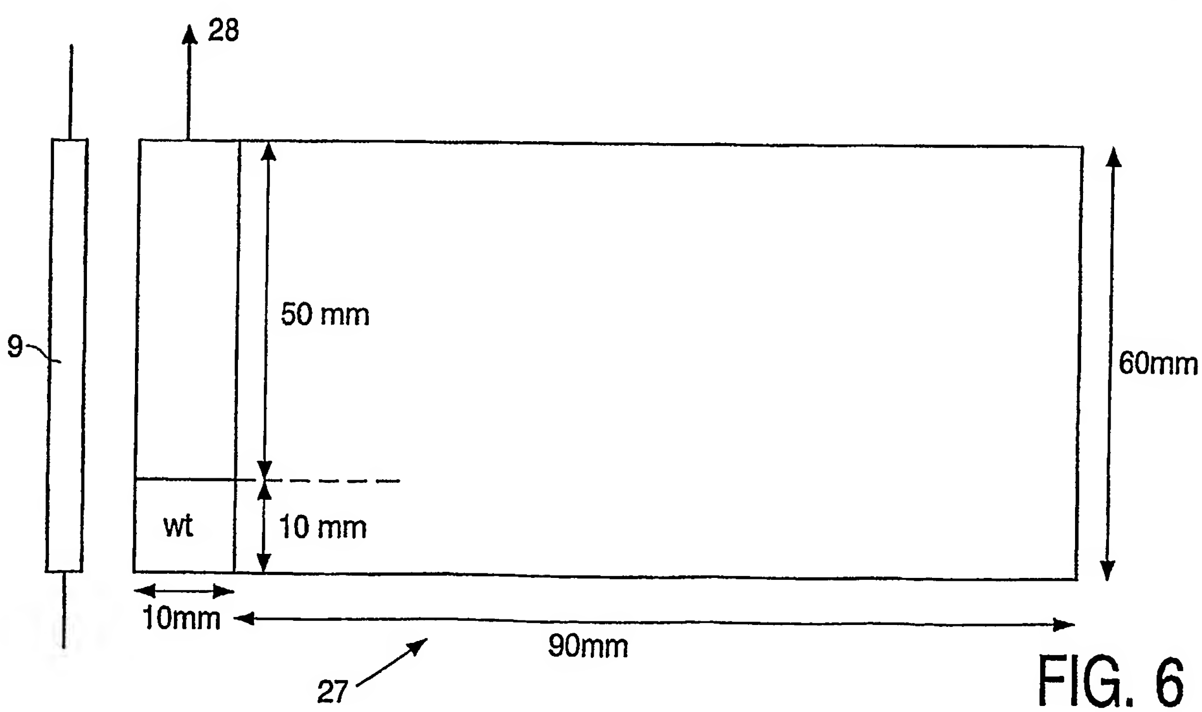

FIG. 6

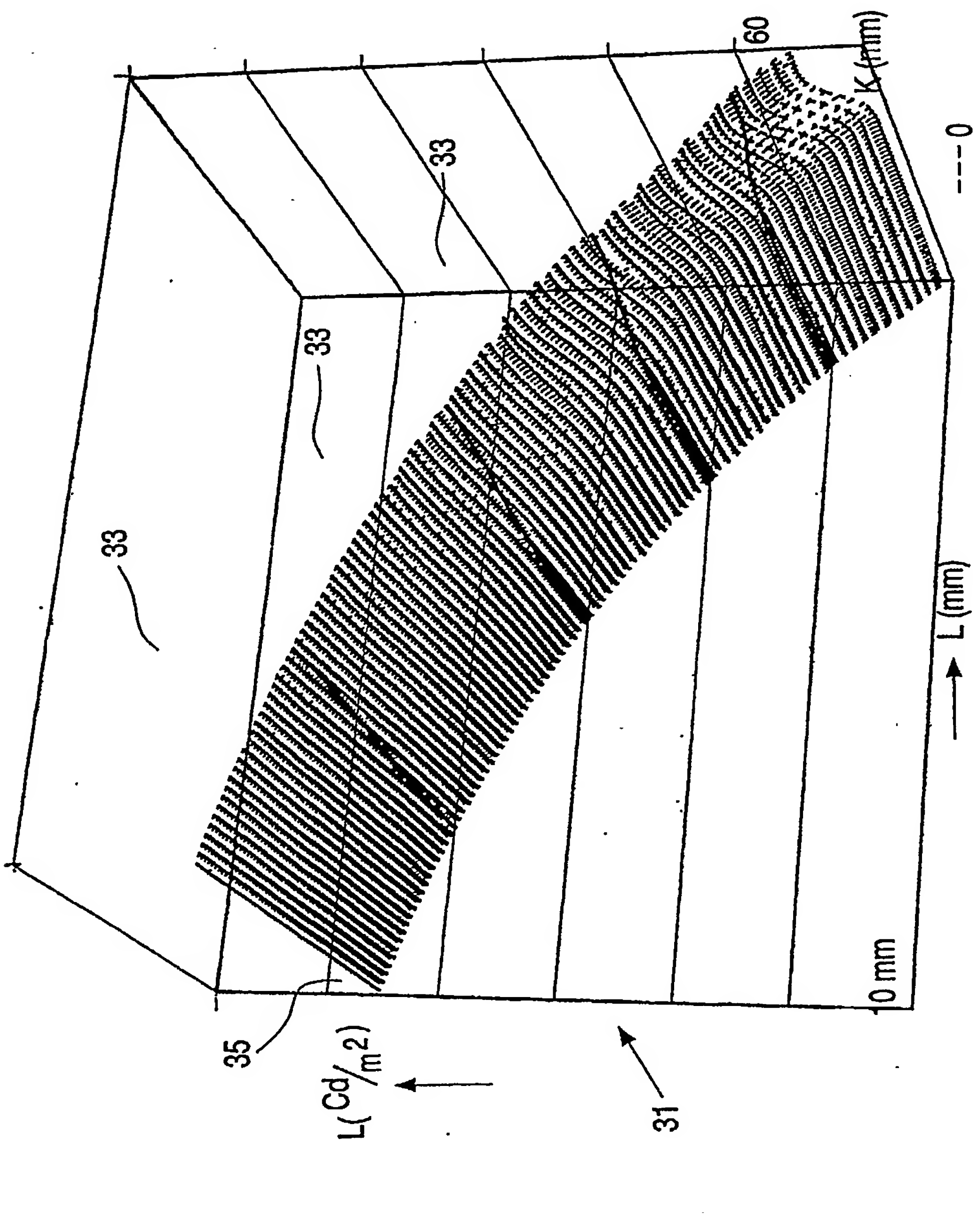

FIG. 7

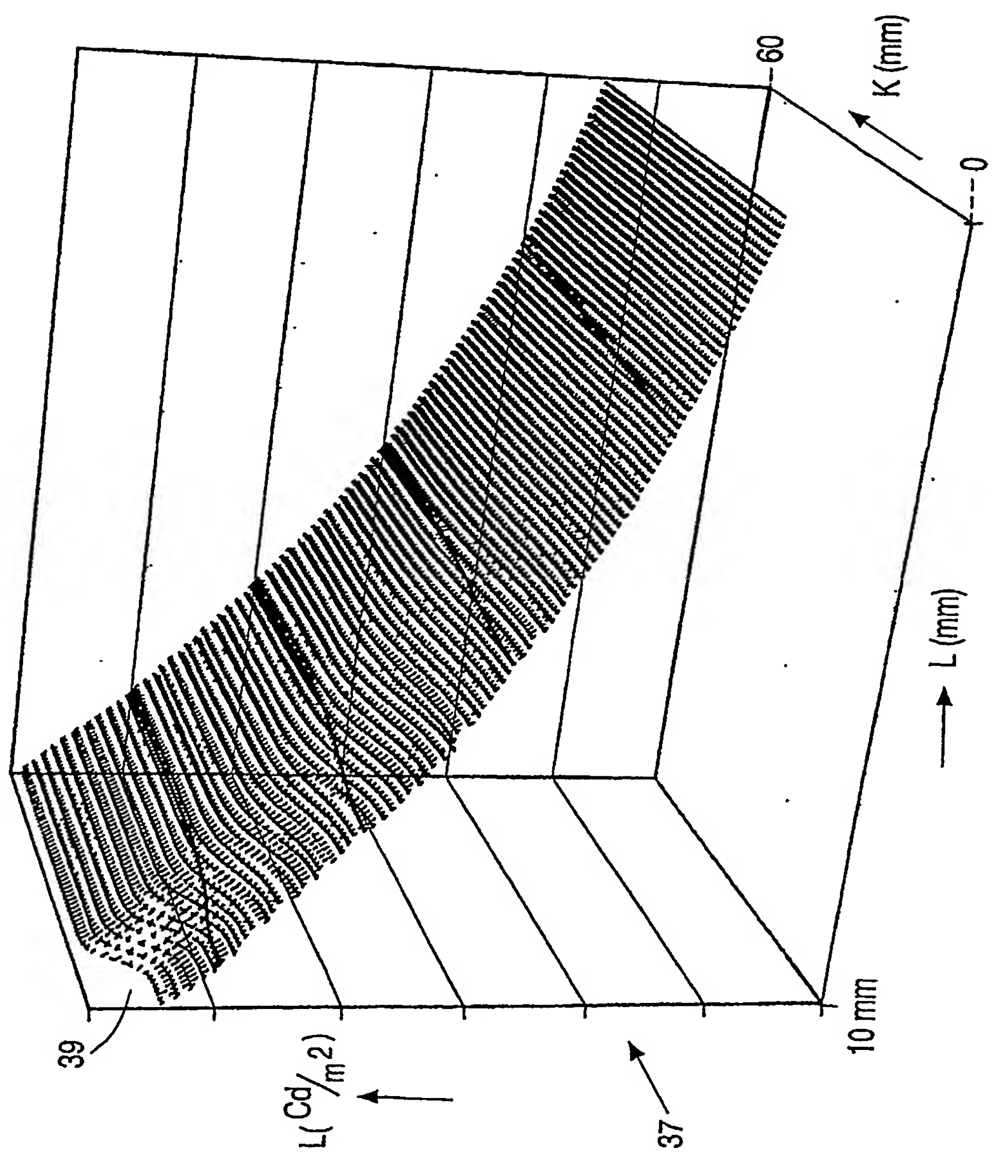

FIG. 8

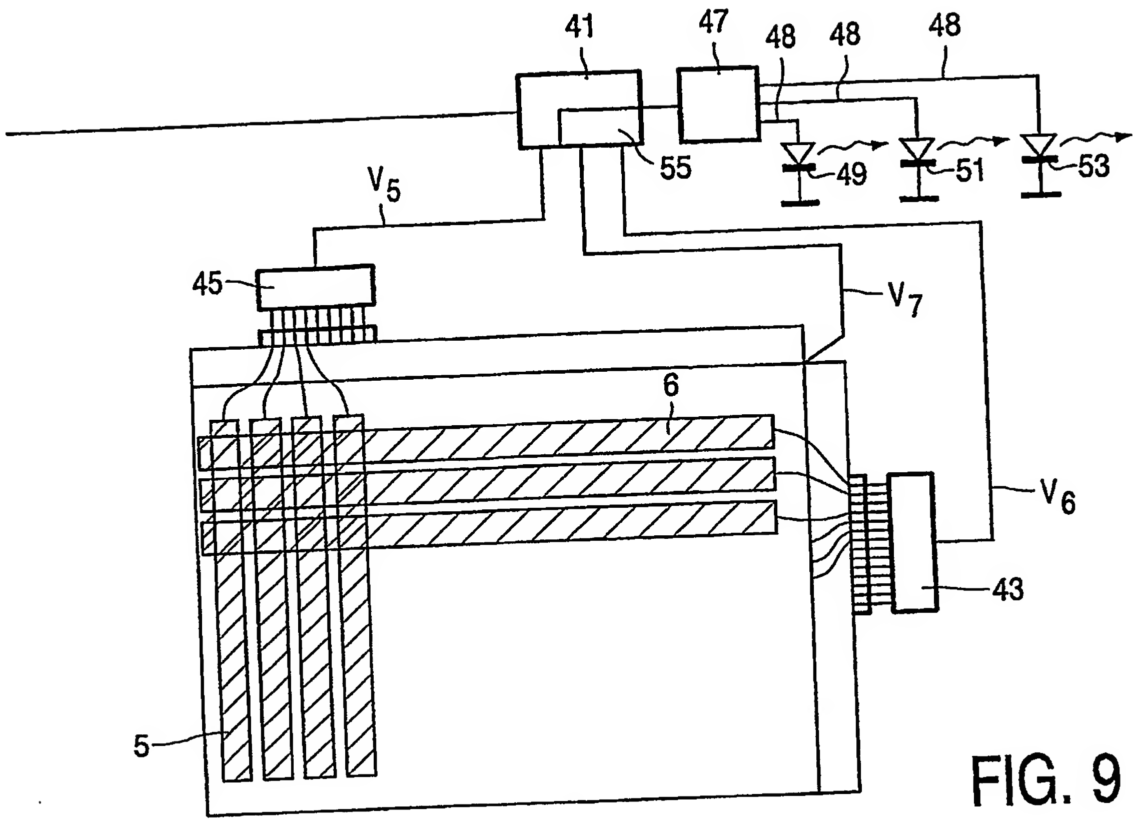
41
47
48
48
48
55
49
51
53
V5
45
V7
6
V6
43
5

FIG. 9

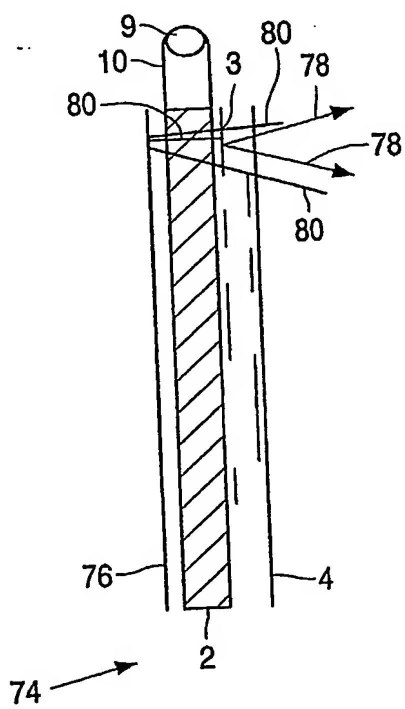
9
80
10
3
78
80
78
80
76
4
2
74

FIG. 12

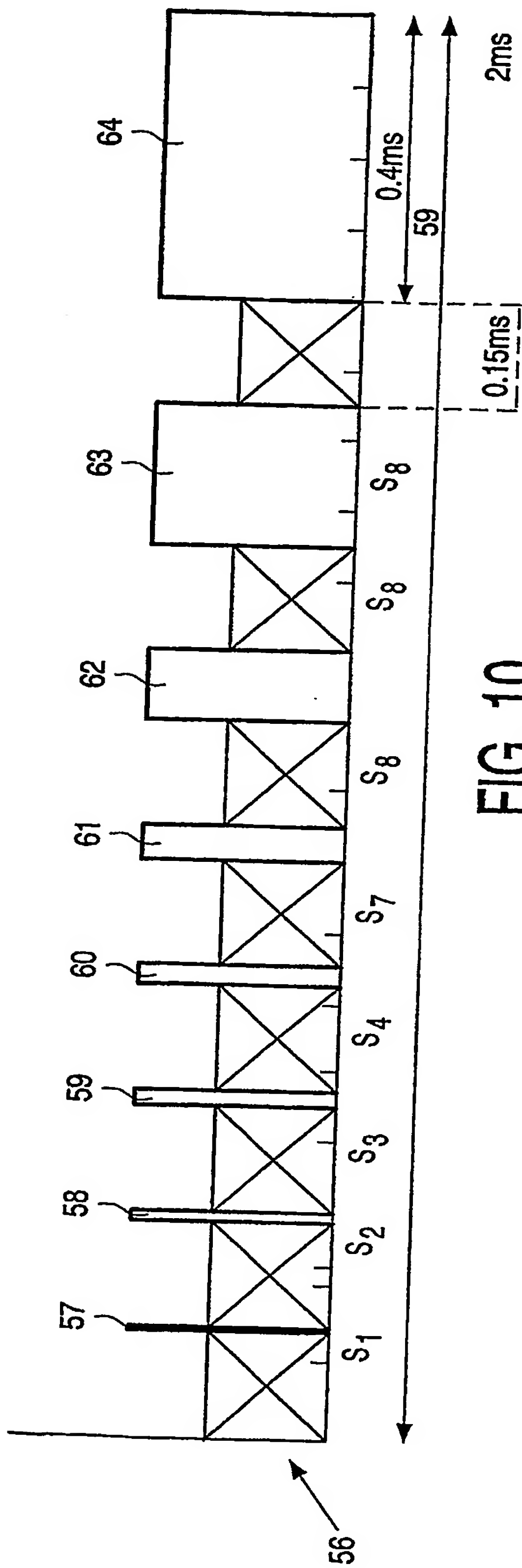
64
63
62
61
60
59
58
57
0.4ms
59
2ms
0.15ms
S_8
S_8
S_8
S_7
S_4
S_3
S_2
S_1
56

FIG. 10

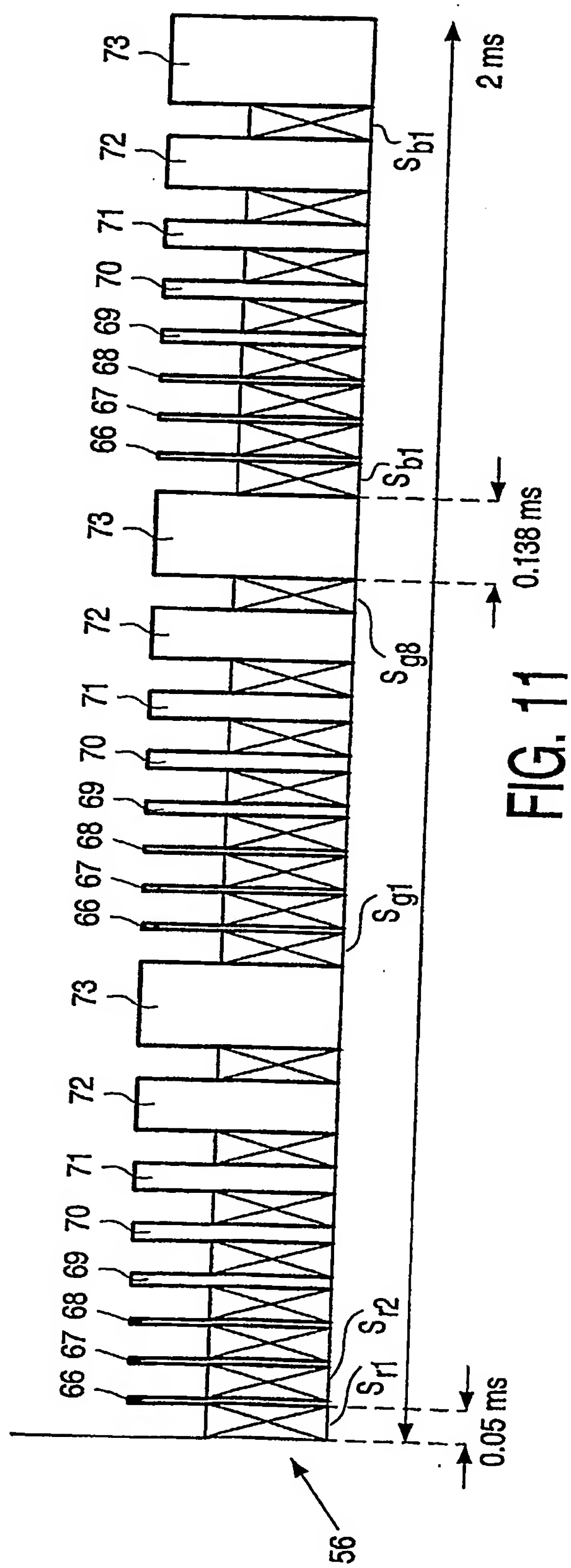
73
72
71
70
69
68
67
66
2 ms
S_{b1}
S_{b1}
0.138 ms
S_{g8}
S_{g1}
S_{r2}
S_{r1}
0.05 ms
56

FIG. 11